Urinary Tract Reconstruction with Bowel

Milestones

1852	First ureterosigmoidostomy (exstrophy)	Simon
1899	First bladder augmentation	Mikulicz
1950	First ileal conduit urinary diversion	Bricker
1972	Clean intermittent catheterisation	Lapides

Principles and techniques

Stomach — usually greater curvature segment raised on right gastroepiploic
Typically pylorus preserving
HCL hypersecretion and loss - therefore hypochloraemic metabolic alkalosis

Ileum — 4m in length
Minimum length to avoid short bowel syndrome 150cm
8-10cm lateral to straight vessel preserves viability of harvested segment

Colon — Typically raised on middle, right or left colic arteries
Anastomotic integrity may be problematic between middle/right colic and superior haemorrhoidal and sigmoidal

Anastomotic principles:

- Adequate exposure
- Meticulous tissue handling
- Good blood supply
- Avoidance of spillage
  - Bowel prep*
  - Soft bowel clamps
- Serosal apposition
- Mesenteric apposition

Multiple methods of bowel anastomosis – preferred option is interrupted, end-to-end extramucosal anastomosis with 3/0 polydioxanone (PDS)

* Small bowel anastomoses typically require no bowel preparation
Mechanical bowel preparation for surgery with possible colonic resection
NB. Bowel preparation reduces number of bacteria but not concentration
Options

1. Osmotic/Stimulant laxatives (eg. Picolax/Fleet)
   Low residue diet 48 hours pre-surgery (see appendix)
   2 sachets of sodium picosulphate (Picolax) or sodium phosphate (Fleet) at noon and 6pm on day before surgery
   Problems with loss of water and electrolytes. Some reports of life-threatening hyperphosphataemia and hypocalcaemia with sodium phosphate
   Care in elderly or those with CCF or valvular heart disease due to large fluid shifts – thus these patients should receive IV fluids overnight
2. Iso-osmotic laxatives (e.g. Go-lytely)
   Low residue diet 48 hours pre-surgery

Polyethylene glycol admixed with 4L water over 24 hours.
Less fluid shifts cf. above but often poorly tolerated due to need to drink large volumes of salty-tasting water

Antibiotic bowel prep?
Controversial
Popular in US, less so in Europe
Increased risks of diarrhoea, thrush and pseudomembranous colitis
? improved outcomes vs. standard peri-operative prophylactic antibiotics

<u>Ureteroenteric anastomoses</u>
Many methods of ureteroenteric anastomosis; may be refluxing or non-refluxing. Refluxing include Bricker and Wallace anastomoses (see below)
Non-refluxing

Leadbetter	tunnelled
Griffiths	split-nipple
Kock	intussusception

Renal deterioration a/w reflux of infected urine into upper ureters – theoretically, anti-reflux procedures should reduce renal dilatation and deterioration, but controversial:
Arguments against:
1. Detubularised bowel and ileal conduits are low pressure reservoirs
2. Limited evidence for efficacy in humans
3. Refluxing valves allow for easy surveillance of upper tracts in cancer
4. Urine should be sterile in IC and urinary diversions
5. Non-refluxing valves have higher complication and obstruction rate
6. A significant proportion of upper tracts show bacterial colonisation, even after a non-refluxing procedure
*7. Intra-abdominal pressure is protective as transmitted to all abdomen
*8. Good results from isoperistaltic segment of bowel (12% dilatation or obstruction at 7 yrs median follow-up; Thoeny 2002)

Arguments for:
1. Significant indirect evidence that preventing reflux of infected urine prevents dilatation and renal deterioration
*2. Up to 30% of patients with continent urinary diversions may require ISC and therefore have chronically infected urine

* Only relevant for continent urinary diversions

<u>Refluxing ureteroileal anastomoses</u>
May be implanted individually (Bricker) or conjoined (Wallace).
Wallace associated with lower stricture rates vs. Bricker (Kouba et al J Urol 2007. n=190, 50:50 Wallace:Bricker, 0% vs 2.6% stictures. 2/3 left-sided)
2 types of Wallace: side-to-side vertical (Wallace 1966) and side-to-side transverse (Wallace 1969)

<u>Detubularisation</u>
Law of Laplace Pressure = 2 x Wall Tension / Radius
$P = 2T/R$

Alternatively:

Wall tension = ½ pressure x radius

Tension is usually constant (i.e. surface tension of a bubble, or peristaltic tension of bowel wall, even after detubularisation)
From above, doubling radius halves pressure; thus maximising volume reduces pressure for a given surface tension. Lowest pressure in a sphere, explains value of detubularisation to create a low pressure reservoir.
After detubularisation;

- Initial interruption of coordinated smooth muscle activity
- Gradual return of co-ordination to create peristaltic muscle contractions and subsequent increase in intraluminal pressure

Even allowing for return of co-ordinated contraction, Studer pouch:

- 40cm ileum with radius of 10cm and volume 125ml
- 10cm wide pouch with radius of 4cm and volume 500ml and average intraluminal pressure of 35cm water

<u>Catherisable ports</u>

Used when native urethra unavailable or unsuitable (ie hypersensitivity)
Mitrofanoff principle compressible tube buried within the wall of a reservoir is kept closed by reservoir pressure
Originally described using appendix as a continent vesicostomy in neuropathic children (Mitrofanoff 1980)
Numerous suitable conduits (appendix, fallopian tube, Monti (1997))
Catheterisation of Mitrofanoffs can be difficult – coude tipped catheters reportedly most reliable.

Metabolic and functional consequences

Renal deterioration
Electrolyte and acid base dysregulation
Bone disease
Impaired growth in children
Altered drug metabolism
Mucus production
Infection
Stones
Malignancy
Impaired bowel function
Psychological

Renal deterioration
Causes:
Obstruction*
Infection
Stones

* Obstruction anatomical or functional. Anatomic may be related to stoma, conduit/reservoir, or ureteroileal anastomosis. Functional obstruction may result from high reservoir pressures. Outcome of obstruction = dilatation, leading to stasis, infection and stone formation

Prevalence of renal deterioration depends on definition: dilatation, renal impairment, need for dialysis.
Important to differentiate renal deterioration from normal age-related decline. Studies assessing renal function and urinary diversion should use formal GFR measurement because:
Bowel segments absorb urea and creatinine
Bowel secretes water (unreliable osmolality)
Bowel secretes bicarbonate (unreliable renal acidification studies)

Ileal conduit = 30-50% dilatation, 20% renal impairment, 7% dialysis, 6% death. Data on newer diversions more limited. One long-term study of patients after Kock pouch using Cr-EDTA showed minimal decline in GFR cf. normal aged-related pts (Jonsson 2001). Others have found a global deterioration irrespective of diversion (Kristiansson 1995)

Electrolyte and Acid-Base

Stomach	Hypochloraemic metabolic alkalosis
	Acid urine – can cause dysuria (Rx with PPIs)
Jejunum	Jejunal conduit syndrome – occurs in 25%
	Hypochloraemic metabolic acidosis
	XS leakiness – think sodium bicarbonate loss
	Hyponatraemia
	Hypochloraemia (co-transport)
	Hyperkalaemia
	Acidosis

Alkaline urine

Ileum/colon **Hyperchloraemic metabolic acidosis**

Think absorption of ammonium chloride and loss of bicarbonate
NH4Cl breaks down into NH3 (ammonia) and HCl
NH3 broken down by liver into urea and H+ ions
XS hydrogen ions drive lung compensation lowering bicarbonate (also lost into bowel – colon >> ileum)
Kidneys try to compensate by retaining HCO3 [GFR of 55ml/min thought to be enough to compensate for endogenous acid loads]

Symptoms
- Anorexia
- Weight loss
- Polydipsia
- Lethargy
- Symptoms attributable to bone demineralization
- Impaired growth in children (see below)

Prevalence
- 20% ileal conduit
- 70% ureterosigmoidostomy
  - due to increased bicarbonate loss
  - also higher potassium loss

Treatment
- Sodium bicarbonate replacement (? Adjustment vs. venous bicarbonate) 0.5-1.0g qds

<u>Bone disease</u>

Causes

1. Chronic metabolic acidosis
   - Leaching of calcium from bone by stimulation of osteoclasts and inhibition of osteoclasts.
   - Attempt to buffer acidosis; increased calcium excretion
   - No evidence that acidosis impairs renal conversion to active vitamin D
2. Impaired bowel absorption of calcium and vitamin D
   - Proposed but PTH, vitamin D and calcium levels uniformly normal in most studies

Majority of adults asymptomatic. Rare to have symptomatic osteomalacia, but can be diagnosed on bone biopsy

<u>Growth and development</u>

Controversial

Early reports – most famous Wagstaff 1992 – suggest impaired growth in children after enterocystoplasty. Other reports conflict

Largest prospective study to date of 123 children before and after enterocystoplasty showed unexplained reduced growth (predominantly height) in 15% of patients - ? why (Gerharz 2001)

Abnormal drug metabolism
Recycling of renally-excreted drugs via bowel loop may increase risk of toxicity eg. Methotrexate
Very important in chemotherapy – reservoirs should be catheterized

Mucus production
Continued production of mucus – may be increased
Obstruction, pain (ureteric interposition), rupture and stone formation all reported
Cranberry juice, aspirin, NAC, and ranitidine all used
Recent well designed PC-RCT has shown no evidence of efficacy for NAC, ranitidine or aspirin; cranberry not tested (N'Dow 2001)
NB. Mucus gives high rates of false positive urine pregnancy tests

Infection
Bacteria commonly commensal in IC, CCUD and ureterosigmoidostomy. Should not be present in neobladders
No requirement for treatment, except with upper tract symptoms, and possibly pure growths of pseudomonas/proteus (higher risk of upper tract abnormality)

Stones
Increased risk due to:
- Alkaline urine
- Bacteriuria
- Abnormal anatomy
- Mucus
- Foreign bodies (staples)

Usually ammonium magnesium phosphate (struvite) and carbonate apatite (see below)
Risk of stones particularly high in continent cutaneous (non-gravitational) methods and in those with staples (i.e. Kock, Indiana, Mainz etc.)
Struvite (ammonium magnesium phosphate) is a phosphate mineral with formula: $(NH_4)MgPO_4 \cdot 6H_2O$
Dahlite (Carbonate apatite) is a phosphate mineral with formula: $Ca_5(PO_4,CO_3)_3F$
Stones least commonly seen with gastrocystoplasty – high acid toxic to bacteria and dissolves struvite

Rupture
Uncommon
Needs high index of suspicion
Typically pouches with high leak point pressure and high intraluminal pressure
Presentation may be atypical especially in children but:
- Abdominal pain
- Decreased urine output
- Fever
- Leucocytosis

Diagnosis:
- Laparotomy, drainage of pouch and perivesical space in pts with peritonitis

CT with pouchogram in those with occult presentation

Bowel function

Minimal effect from colonic resection – very adaptive

Resection of terminal ileum/IC valve:

1. Diarrhoea
    - 10% of those retaining IC valve
    - 20% of those losing IC valve
2. Malabsorption
    - Bile salts
    - Fats
    - Vitamins B12
        - Folate required for pyrimidine and purine metabolism.
        - B12 keeps folate in active form
        - B12 deficiency leads to macrocytic anaemia (Not pernicious anaemia – Ab to IF). Takes 2-3 years to become clinically deficient after terminal ileal resection
            - Lemon-yellow skin
            - Raw beef tongue
            - Large immature red cells
            - Megalobalstic marrow
            - Subacute comined degeneration (demyelination) of spinal cord (paraesthetic hands and feet)
        - Effects of urinary diversion controversial
        - Some studies show decreased levels in bladder substitution whereas other do not
        - Loss of 50cm terminal ileum has been reported as threshold for adequate absorption (Pannek 1996)
        - Also depends on measurement: NB. more pts have a cobalamin deficiency when other cobalamins measured (ie. homocysteine)
        - Treatment:
            - Hydroxycobalamin loading = 1mg/month
            - Well tolerated with few side effects
            - Cheap (< £10 per year) – more expensive to monitor levels
3. Cholesterol gallstones

Malignancy

1. Risk of mixing urinary and faecal streams well characterized in ureterosigmoidostomy
    - Incidence 3.5 - 19%
    - ~1500 x increased risk cf. general population
    - 90% anastomotic
    - 95% adenomatous
    - Faeces and urine admixture crucial for liberation of carcinogenic initiating chemicals (?N-nitroso compounds).
    - Long lag-time – 18 yrs for benign tumour; 23 yrs for malignant tumour
    - No difference in risk with new modifications
    - Role for screening sigmoidoscopy not defined

2. Risk of malignancy in patients with bowel mucosa exposed to urine (without faeces) is unknown

No malignant neoplasms in ileal conduits (adenomas occasionally)
A small number of pouch neoplasias have been identified, a majority in patients with diversion for TB bladder. Interestingly most occurred around anastomosis, suggesting urothelium may be susceptible rather than enteric mucosa.
High levels of nitrosamines identified in cystoplasties, particularly in those with positive urine cultures: ?bowel mucosa permissive for persistent infection, leading to bacterial conversion of urine, with subsequent initiation of cancer in urothelium.

Psychological

~25% pt report significant psychological symptoms post-operatively
Sexual and relationship problems
Impaired emotional and mental wellbeing
Problems with self esteem and social interaction
No conclusive evidence to date that one form of urnary diversion any better than another

Contraindications to reconstruction with bowel

Renal impairment
Hepatic impairment
Bowel impairment
Short bowel syndrome
Inflammatory bowel disease
Pelvic radiotherapy
Inability/unwillingness to perform ISC*
Receiving chronic immunosuppressants*
Psychiatric illness*

* Applies to retentive diversions (pouch/clam). A GFR of < 60ml/min considered inadequate to allow compensation for chronic metabolic acidosis. Age > 65 years appears to be associated with an increased risk of nocturnal urinary incontinence in those receiving an orthotopic neobladder.

Appendix

UHL Low residue diet instructions

Foods to avoid

- **Meat** – sausages, burgers, pies, ready prepared meals.
- **Fish** – no batter or breadcrumbs, fish with bones, tinned in oil or tomato.
- **Bread** – wholemeal, brown or granary, wholemeal flour.
- **Potatoes** – jacket, roast or chipped, crisps.
- **Rice/pasta** – brown rice, all types of pasta.
- **Nuts** – all types.
- **Vegetables/salad/fruit** – all types.
- **Sweets** – chocolate, toffee, fudge.
- **Sugar** – jams, marmalade with skins, seeds, pips, or whole fruit.
- **Desserts** – puddings, pies, cakes, pastries, biscuits.
- **Beverages** – fruit juices.

Foods you may eat

- **Meat** – lean meat, poultry, bacon, offal.
- **Fish** – fresh, frozen, tinned in brine.
- **Cheese** – any type.
- **Eggs** – boiled, poached, scrambled.
- **Milk** – ½ pint daily, full cream, semi-skimmed or skimmed.
- **Fats** – butter, margarine – ½oz daily, OR low fat spread 1oz daily.
- **Bread** – white only, no more than 4 slices per day OR
- **Chapatti** – made with white flour (no 1) no more than 4 daily.
- **Potatoes** – boiled or mashed, 4 egg size per day OR
- **Rice** – white 4 tablespoons per day.
- **Sweets** – boiled sweets, mints, jellies.
- **Sugar** – brown/white, honey, syrup, jelly-type jam or marmalade.
- **Desserts** – jelly.
- **Beverages** – tea, coffee, (milk from allowance) lucozade, fizzy drinks, ribena, oxo, Bovril, marmite, wine, beer.
- **Seasoning** – salt, vinegar, ground pepper.